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ABSTRACT

In the spring of 1979, an experimental study was conducted to evaluate the possible effects on preservice teachers of Reflective Teaching, a new instructional alternative for teacher education that features peer teaching and evaluation. One of the hypotheses about Reflective Teaching stated that, as a result of engaging in Reflective Teaching, students will subsequently be better able to think and talk critically about teaching and learning. The hypothesis was tested by asking each subject in both the treatment and control groups to complete two sentence stems ("When I think about teaching..." and "When I think about learning...") before and after the experimental and control treatment conditions. The resulting sentences were subjected to a structural analysis and coded into three mutually exclusive, inclusive categories: analytical, evidential, and declarative. The coding was then subjected to log linear analysis which found that students who had the Reflective Teaching treatment were more likely to produce utterances coded as analytical. (Authors/JN)

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The Experimental Effects of Reflective Teaching on Preservice Teachers' Ability to Think and Talk Critically About Teaching and Learning

by

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ABSTRACT

In the spring of 1979 an experimental study was conducted to evaluate the possible effects on preservice teachers of Reflective Teaching, a new instructional alternative for teacher education. This paper reports the testing of one of the hypotheses about Reflective Teaching, namely, "That as a result of engaging in Reflective Teaching students will subsequently be better able to think and talk critically about teaching and learning." The hypothesis was tested by asking each subject in both the treatment and control groups to complete two sentence stems ("When I think about teaching . . ." and "When I think about learning . . .") before and after the experimental and control treatment conditions. The resulting sentences were subjected to a structural analysis and coded into three mutually exclusive, inclusive categories: analytical, evidential, and declarative. The coding was then subjected to log linear analysis which found that students who had the Reflective Teaching treatment were more likely to produce utterances coded as analytical.

This paper is one of a series on Reflective Teaching presented at the Annual Meeting of AERA in Boston, Massachusetts in 1980:

1) Williams, E.J. and Hough, J.B., "The Experimental Development and Field-Testing of Reflective Teaching Lessons."

2) Williams, E.J. and Kennedy, J.J., "The Effects of Reflective Teaching Relative to Promoting Attitudinal Change."

3) Nott, D.L. and Williams, E.J., "The Experimental Effects of Reflective Teaching on Preservice Teachers' Ability to Identify a Greater Number and Wider Variety of Variables Present During the Act of Teaching."

4) Wilsman, M. and Kennedy, J.J., "Variations in Preservice Teachers' Modes of Reflecting About Teaching According to Their Conceptual Levels and Participation in Reflective Teaching."

The Introduction and Design Sections of these papers are similar.

The Experimental Effects of Reflective Teaching on Preservice Teachers' Ability to Think and Talk Critically About Teaching and Learning

The purpose of this paper is to describe the testing of the hypothesis "As a result of engaging in Reflective Teaching students will subsequently be better able to think and talk critically about teaching and learning." This hypothesis was one of several that were tested during the Spring 1979 evaluation of Reflective Teaching that was conducted in the College of Education of The Ohio State University under a grant from The Exxon Educational Foundation.

Development of Reflective Teaching

Reflective Teaching was "born" or "invented" in a general methods teacher education class at The Ohio State University. The instructors of the several sections of the course and the course's director, Professor Donald R. Cruickshank, were interested in finding an instructional alternative that would give preservice teachers more opportunity to teach in a laboratory (classroom setting). In addition, this instructional alternative should be technically simple--that is, not call for special equipment (videotape cameras, recorders and the like), and should provide the preservice teachers with the opportunity to carry through a complete act of teaching--planning, execution, and evaluation--in a fifty minute class period.

Out of this conscious effort to add to the repetoire of on-campus clinical or laboratory teaching experiences available to teacher educators, Reflective Teaching evolved during the years 1973-1979. It should be noted that Reflective Teaching grew out of the actual experiences of the students and instructors of the general methods class; its elements were created and refined out of actual classroom practice.

Description of Reflective Teaching

There are two principal elements to Reflective Teaching. First, there is the Reflective Teaching Lesson (RTL). An RTL is a set of materials which provides (1) a teaching objective that can be met in 10 to 15 minutes, (2) whatever information the designated teacher will need in order to meet the objective, and (3) a way to assess the teaching to find out whether or not the learners learned the criterion material and their satisfaction with the teaching and learning.

The second element is the Reflective Session. Reflection simply means the careful consideration of what occurred during the teaching of the Reflective Teaching Lesson. Because members of the education class have shared a common teaching/learning experience, it is possible for them to use the information gathered during that experience to think about teaching in specific and concrete ways. For example, in some of the learning groups more learners will achieve higher scores on the posttest than will others. The students can reflect--consider in the light of the evidence--possible reasons for such

differences. The Reflection is usually done in two parts. First, in the individual learning groups, 5 to 10 minutes is spent reviewing the immediate experience. The designated teacher can explain his/her goal and can explain how the planning was done. The learners can give the designated teacher more information about what happened during the teaching from their perspective. Next, the small learning groups are brought together by the college instructor. Now the reflection can include more information. The students can find out how different teachers-working to the same objective as defined and measured in the Reflective Teaching Lesson--planned, executed, and evaluated the RTL. In this setting more generalization is possible and students can project ahead to future teaching experiences.

Here are the events which take place in a teacher education class in which Reflective Teaching is being used:

First, the college class is divided into groups of 4-6 students; a teacher is designated for each group.

Second, each designated teacher receives the same Reflective Teaching Lesson (about 35 different RTLs are currently available) and prepares to teach it during the next class session.

Third, each designated teacher teaches the learning group so that its members can meet the objective stated in the RTL. The designated teachers then evaluate the learners' achievement and assess their satisfaction.

Fourth, reflection on the teaching takes place during the small and large group discussion.

Fifth, a new generation of designated teachers is chosen and given another RTL.

The Experimental Study of Reflective Teaching

In 1978 Professor Donald R. Cruickshank applied for and received a grant from the Exxon Education Foundation for the purposes of developing and evaluating Reflective Teaching. The two year grant provided Professor Cruickshank with the resources to further develop Reflective Teaching as to materials, procedures, and conception. An important part of this effort was the design and execution of an experimental study to find out what in fact happens when Reflective Teaching is used in a teacher education class.

Origin of hypotheses tested during Experimental Study

During the years of its evolution, Reflective Teaching provided its users with a number of guesses as to what it actually did in a general methods class. These guesses became the foundation for the hypotheses that were tested during the field experiment. Among these guesses about the effects of Reflective Teaching was one that suggested that students who engaged in Reflective Teaching would be better able to think reflectively about teaching and learning. This guess became a hypothesis in the study and was stated: "As a result of engaging in Reflective Teaching students will subsequently be better able to think and talk critically about teaching and learning."

Theoretical and Experimental Importance of the hypothesis

In addition to being one of the projected results of engaging in Reflective Teaching, this hypothesis is an important one because of the theoretical and experimental findings that indicate that a close relationship exists between one's ability to use language and one's thought--that is, that language does not simply reflect thought, but that language to some extent influences thought itself (Craig 1976, p. 242). Berelson and Steiner (1967), in their summary of knowledge about human behavior say:

> Their language enables human beings, not only to communicate their thoughts in ways that other people can understand, but also enables them to think about things that are not immediately present or may not ever have been experienced. Not only that: people can more readily distinguish between things they have different names for, and vice versa. For example, more colors can be identified by people who have names for them and Eskimos--as well as American skiers--distinguish several different kinds of snow by name. (p. 123)

Thus if preservice teachers were better able to talk critically about teaching, there would be some support for suggesting that they were thinking better about teaching and learning as well.

In addition, if Reflective Teaching can be shown to have some relation with that particular mental activity called reflectivity, it would meet Dewey's view of the uses of practice teaching. "Practice work thus considered is admistered primarily with references to the intellectual reactions it incites, giving the student a better hold upon the educational significance of the subject-matter he is acquiring, and of the science, philosophy, and history of education" (NSSE Yearbook 3, pt. 1. Chicago, 1904, p. 3. See also, Wilsman and Kennedy, 1980).

Design

The design structure employed to evaluate the extent to which RTLs appear to achieve their purported objectives was essentially a classical two group pretest-posttest control group design augmented by two nested variables, namely (a) sections of ED:F&R 435 and (b) RTL groups (subgroups consisting of 5 or 6 students within sections of ED:F&R 435). The principal variable consisted of exposure to the RTL condition and non-exposure to (the control condition). As noted above, four intact sections of ED:F&R 435 participated in the study. The assignment of the sections to the two levels of the treatment variable was random.

Since Reflective Teaching, by its nature is a small group (initially) activity, the sections were divided into groups of 5 or 6 students. Assignments of students to the respective groups was done randomly. These groups therefore constituted an additional nested factor, at least four of which were nested within each of the two levels of the section factor. Finally, the pretest and posttest information provided by participating students was treated as a within-subjects variable

(i.e., a repeated measure) and subsequently built into the overall design structure.

The design arrangement which governed the data collection in this experiement may be described as a partial hierarchical design with repeated measurements (see Kennedy, 1977, pp. 538-551).

Generic Design Structure RT Field Experiment

Treatment Conditions	Sections Within Treatment Treatment	Groups Within Sections: Video Taping	No Video
Treatment: Students exposed to RTL	Section 1	Group 1 (n=6)	Group 3 (n=5)
			Group 4 (n=5)
		Group 2 (n=6)	Group 5 (n=5)
			Group 6 (n=5)
	Section 2	Group 1 (n=6)	Group 3 (n=5)
		Group 2 (n=6)	Group 4 (n=5)
Control:	Section 1	Group 1 (n=5)	Group 3 (n=5)
		Group 2 (n=5)	Group 4 (n=5)
Control: Students exposed to an alternative activity	Section 2	Group 1 (n=6)	Group 3 (n=5)
			Group 4 (n=5)
		Group 2 (n=5)	Group 5 (n=5)

Methods of Testing the hypothesis

The hypothesis was tested using four sections of a general methods education class for secondary teaching majors. The class is designated as Educational Foundations and Research 435 at the Ohio State University. Students were randomly assigned by conversion computer scheduling to the four sections. Two of these sections were randomly designated as treatment sections and the remaining two were designated control sections. Four instructors, three Reflective Teaching staff members and another graduate teaching associate were then randomly assigned to the four classes to teach the experimetal part of the course. This consisted, for the treatment sections, of two hours of Reflective Teaching on three consecutive Thursdays in April of 1979 (April 5, 12 and 19). This meant that each student would receive 6 hours of Reflective Teaching--either as a learner (5 hours) or as designated teacher (1 hour). The sections were divided into groups having either 5 or 6 students. Thus in a group of 6 each student would teach once and be a learner 5 times. Further to provide the experimenters with a comprehensive record of the Reflective Teaching events, two of the learning groups in each section were randomly chosen to be videotaped during both the teaching and small group discussions. In addition, all of the large group discussions were videotaped. Thus in the experimental groups, there exists a record of 24 small group teaching and reflection and 12 large group reflective sessions--two RTLs were done during each 2 hour class

period.

The two control sections were likewise randomly divided into groups of 5 or 6 students. During the three Thursdays, the control sections were given the alternative treatment. A set of materials was gathered and made into a packet relating to the Growth of Professionalism 1800-1918. These packets became the basis for what the control sections did during the experiment. The control treatment was designed to be educationally valid and not simply a placebo. However, it was designed to differ from the experimental treatment in this way: Reflective Teaching gives students a chance to be involved in an actual, although scaled-down teaching experience. Then the opportunity is given for the students to reflect in a structured setting on the elements of the experience. The control groups were similarly given the opportunity to reflect on teaching, but in that case the teaching was experienced vicariously through the reading of the experiences of others (for example, of the first experience as a teacher). Thus the control groups differed from the experimental in their relation with teaching. In one case it was direct, in the other vicarious. It should also be noted that both the experimental and the control groups engaged in microteaching and were alike in every other way save for the 6 hour treatment period.

The experimental sections had 24 and 31 students respectively for an N of 55. The Control sections had 26 and 20 students respectively for an N of 46.

Each of the hypotheses in the study was to be tested by the use of a pre- and posttest instrument designed to detect differences of a before and after nature. The pretest instruments were administered to both experimental and control sections on the Thursday preceding the commencement of the study (29 March) and the posttest was administered on the Tuesday following the conclusion of the experiment (24 April).

The pre- and posttest instrument designed to test the hypothesis consisted of two sentence stems ("When I think about teaching..." and "When I think about learning...") that were to be completed by each of the participants. Here are the directions for that part of the pre- and posttest:

> On the following pages you will be asked to complete certain phrases with a short paragraph.
>
> On each page you will find the beginning of a sentence and your task is to complete it and add three sentences to it.
>
> For example, I like...
>
> When you are given the signal turn to the first page, complete the sentence given and write at least three additional sentences. You will be given two minutes for each page. After 1 1/2 minutes we will say, "Finish the sentence," and at 2 minutes we will ask you to turn to the next page. Make sure you complete your last sentence. There are two pages in all.
>
> Write your sentence as quickly but as clearly as possible.
>
> Please wait for the signal to turn to a new page.

These directions were read aloud by the test administrator and the subjects

were asked to follow along, reading silently.

On the Tuesday following the treatment (24 April), the post-test was given. During both the pre- and posttest sessions, the sentence completion was the first testing instrument confronted by the subjects.

By the completion of the experiment the investigators had two sets of utterances of each of the subjects in both the control and experimental sections. These utterances sampled the thoughts of the subjects on the general topics of teaching and learning. The first sample was taken during the very first week of an eleven week quarter and immediately after the experimental treatment was concluded. The utterances of any individual were thus available for analysis as were the aggregated utterances of the four sections and also the aggregation of the experimental and control sections.

Supplementary instrumentation

In addition to the instrumentation to formally test the hypothesis, the staff administered posttest only inventory to the Reflective Teaching Treatment group. The inventory was designed to find out the perceptions of the Reflective Teaching participants about their experience in the Treatment. To complete the inventory each participant was asked to respond to a series of completions to the stem "As a result of your six hour experience with Reflective Teaching..." The response was to be on a Likert-type scale with "I strongly believe" and "I strongly do not believe" at the extreme ends of the 6 point scale. Of the 34 completions, 3 appear to address the hypothesis: 8 ("...do you believe you could better project hypotheses about teaching and learning"), 9("... do you believe you feel more positively to reflecting on and talking about teaching"), and 15 ("... do you believe you are able to think of a greater variety of ways to accomplish a learning objective?"). The responses to this inventory will be reported at the conclusion of this paper.

Finally, the videotaping of the randomly selected learning groups and all the large group discussions during the experimental study provided one further source of evidence about Reflective Teaching. A possible interpretation of this evidence will also be reported at the conclusion of this paper.

Analysis of the thought samples

The next task of the investigators was the determination of the possible effects of the treatment on the subjects along the dimension of their ability to think and talk critically about teaching and learning. In order to make such a determination the investigators needed to find a valid and reliable way to operationalize the notion of thinking and talking critically and apply it to the sample.

This task could be accomplished through an examination of the overt structure of the utterances generated by the participants in the study. The English language lends itself to such analysis because its grammatical structure is dependent upon the ordering of words rather than on endings or internal alteration of words

(ablaut) in languages like German. Thus a basic arrangement of word order from a simple thought into one of considerable sophistication, complexity, and nuance. Such growth or transformation may thus imply the sophistication, complexity, and nuance of the writer's mind. For example, beginning with the stem "Teaching is exciting," we can find it transformed successively into "Sometimes teaching is exciting," to "Sometimes teaching is exciting when my students learn the criterion material because I know I have accomplished my basic task as a teacher." The first statement is a simple assertion, the second has altered the assertion into a conditional statement that gives the reader a more complete view of the thought behind the utterance--teaching is exciting only when some condition is met. The third utterance takes us to the level of both a conditional statement and an attempt to define more precisely the role of the teacher. Some presumption may be made that the third utterance reflects a more critical and thoughtful view of teaching than does the first.

Thus the analysis of the talk about teaching may be seen as the analysis of how the students transformed the basic stems into utterances reflecting various levels of complexity. Because the utterances were written, the investigators had a stable and objective set of data about which reliable analysis is possible.

Using these general assumptions and a particular example of how such a system of analysis could be used (Ellsworth, Western Political Science Quarterly 18 (1965), pp. 794-802) a three category system for analyzing the thought samples was devised.

Each sentence in the pre- and posttest instruments could be placed into one of the three categories. It should be noted that the categories are here arranged hierarchically from least to most thoughtful.

1. Declarative (D): A sentence was judged Declarative if it was a grammatically simple sentence which avverred a "fact" but which did not modify that fact (by the use of adjectives or adverbs). Example: "When I think about teaching (stem): I get excited (added by student).

2. Evidential (E): A sentence was judged Evidential if it expanded the simple declarative sentence by adding "what" or "which" clauses and plain "if" clauses (one not complemented by "then" clauses), a definition, a list of specific modifying adjectives or phrases. Example: "When I think about teaching" (stem) I think about sharing, a reciprocal giving and receiving. I think about things which are relevant to my life.

3. Analytical (A): A sentence was judged to be Analytical if it is a complex, compound, or compound-complex sentence of the form "when...then," "If...then," "A teacher should....because then students learn better," or, which makes a distinction between two or more things: "I have had good teachers and bad teachers and somtimes I liked the bad ones." or, the sentence lists the elements of something: "Good teachers are those who...and...and...." Or, "I think about teaching meaning really understanding what is going on and remembering it."

Coding

The principal work of coding was done by one of the investigators, an experienced teacher of composition, who also formulated the system of analysis. The coding was done for each of the subject's responses and then repeated until the coding could be done with a high degree of intrarater reliability. Here follows samples of coded responses. The letter in parenthesis indicates the category to which the response belongs:

(From the experimental sections)

Stem: When I think about teaching...(pretest)
Response: "...I think about what lies ahead of me as a teacher in a secondary school (E). I question what I need to do to prepare myself to do a good job (E). I question the job openings (D).

Stem: When I think about teaching...(posttest--same subject)
Response: "...I now have more self-confidence (D). I have taught something I was unfamiliar with and enjoyed it (A). I am excited to teach something I already enjoy and hope the results will be as good as RTL (A).

Discussion of coding: In the pretest the subject, in the first two sentences makes the basic declaration "I think about what lies ahead of me..." and adds the modifiers that confirm the place of these sentences in the E category. The reader knows more specifically that the basic assertion is grounded on some concrete evidence or specifics. The subject knows what lies ahead in a secondary school and wants to know what will be needed to do a good job. The last sentence is a simple declaration. In the posttest the same subject begins with a simple declaration about self-confidence. The other two sentences are complex in structure and tell the reader that the subject has made a complex statement about the teaching experience in RT. The statement is of the nature of a distinction--even though the subject has taught unfamiliar material, the subject has found the material enjoyable to teach. And second, the subject compares the Reflective Teaching experience with projected future experience, making the distinction that puts both sentences into the Analytic category.

Results of Coding

Table 1
Percentage of Statements Generated for Each Category
(expressed as whole numbers)

Section:	I (Exp)		II (Control)		III (Exp)		IV (Control)	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
When I think about teaching:								
% of A Statements	17	38	21	22	23	35	15	15
% of E Statements	45	33	46	35	47	36	50	54
% of D Statements	39	30	33	44	30	29	30	31
When I think about learning								
% of A Statements	36	40	35	29	41	55	20	20
% of E Statements	36	39	49	39	40	28	48	48
% of D Statements	27	21	18	32	19	16	48	48

Simple inspection of the Table indicates that the experimental sections exhibited changes in the percentage of A or Analytic statements generated after treatment. The percentage of E and D statements declined. The Control sections show changes in the percentage of D statements--increasing this number after treatment. The pattern (Expermental sections increasing the percentage of A statements: the Control sections increasing the percentage of D statements) obtains for both the Teaching and the Learning stems.

Table 2 simply aggregates the Experimental and Control sections to show the pattern of changes.

Table 2
Net Change of Experimental and Control

When I think of teaching...	Experimental (Sections I & II)			Control (Sections II & III)		
% of A Statements	Pre- 40	Post 53	Change +13	Pre- 36	Post 37	Change + 1
% of E Statements	96	69	+23	96	89	- 7
% of D Statements	69	59	-10	63	75	- 7
When I think about learning						
% of A Statements	77	95	+18	55	49	- 6
% of E Statements	76	67	- 9	97	87	-10
% of D Statements	46	37	- 9	66	80	+14

Simple inspection of the results indicates that they support the hypothesis. Students in experimental groups generated more analytical statements post- than did the control students on both stems. Students who had the Reflective Teaching treatment appear to be more likely to generate statements that may be coded A while the Control students generated more simple D statements posttest.

In addition, two separate analyses, using a log-linear approach, were performed on the teaching and learning data for pre- and post-test scores by experimental and control treatment groups. For each analysis data was categorized by the following schema:

1. Treatment (A_j where $j = 1,2.$):
   a) A_1 = exposure to RT.
   b) A_2 = exposure to control activities.

2. Pretest ($B_k = 1,2,3,4.$):
   a) B_1 = equal probability that a student's pre-test statements are in at least two of the categories: analytic, evidential, and declarative.
   b) B_2 = a student has at least 2 pretest statements in the analytic category
   c) B_3 = a student has at least 2 pretest statements in the evidential category
   d) B_4 = a student has at least 2 pretest statements in the declarative category

3. Posttest (C_j = 1,2,3,4.):
   a) B^1 = equal probability that a student's posttest statements are in at least two of the categories: analytic, evidential, and declarative
   b) B_2 = a student has at least 2 posttest statements in the analytic category
   c) B_3 = a student has at least 2 posttest statements in the evidential category
   d) B_4 = a student has at least 2 posttest statements in the declarative category

Subjects were classified into pre-posttest categories in a contingency table control vs. Reflective Teaching group by their predominance of usage of pre-posttest scores. One analysis was done for each of the two stems: When I think about teaching, and, When I think about learning (Teaching Stems Completion and Learning Stems Completion respectively). The results of each are presented below.

The Log Linear analysis was used for examination of the frequencies for the Teaching Stem Completion by the conditions: Treatment (A), Pretest (b), and Posttest (c), as shown in Table 3.

Table 3*
Observed Frequencies for Teaching Stem Completion
by Treatment and Pretest and Posttest Conditions

Posttest (C)	Pretest (B)	Treatment (A) Experimental	Control
Equiprobable	Equiprobable	9	3
	Analytic	1	1
	Evidential	7	5
	Declarative	3	4
Analytic	Equiprobable	7	1
	Analytic	4	0
	Evidential	6	1
	Declarative	0	0
Evidential	Equiprobable	2	4
	Analytic	1	1
	Evidential	7	10
	Declarative	1	4
Declarative	Equiprobable	0	3
	Analytic	0	2
	Evidential	0	7
	Declarative	7	0

*Tables 3-12 are done with the assistance of Jane Williams.

Tables 4 and 5, presented below assisted in further analyses of the data. Since the Posttest scores (C) can be considered a dependent variable, only a logits analysis pertaining to C was undertaken.

Table 4
Summary of Hierarchical Analysis for Teaching Stem Completion by Treatment, Pretest and Posttest Conditions

model	Residual Chi-Square			Component Chi-Square		
	X^2_{LR}	df	p	X^2comp	df	p
(0)	75.58	30	0.000	73.90	1	0.00
(1)	55.42	28	0.002	51.27	1	0.005
(2)	70.76	28	0.000	72.67	1	0.000
(3)	47.54	21	0.001	46.53	1	0.000
(4)	34.95	21	0.029	39.08	1	0.096
(5)	35.37	15	0.002	31.43	1	0.008
(6)	19.72	9	0.020	18.06	1	0.035
(7)	0.00	0	1.00			

Note: $\sum_{i=0}^{7} X^2$ comp = 332.94

Table 5
Logit Analysis of Teaching Stem Completion by Treatment and Pretest Conditions

source	df	X^2_{LR}	p
Total	21	47.54	
Due to Pretest	9	13.84	0.128
Due to Treat/Pretest	3	13.97	0.003
Due to Interaction	9	19.72	0.020

Acknowledgement must be given that the saturated model for this data implies interaction and may be significant, however, examination of the normal deviate tests of specific interaction parameters all failed to achieve significance. Moreover, the a priori hypothesis and concern focused primarily on treatment groups. Consequently, the principal interest was directed toward the full first-order interaction indicating conditional main effects, i.e., main effects due to treatment partialling out the pretest (χ^2_{LR} = 13.37, $p < 0.003$ with 3 degrees of freedom). To follow up this main effect, the parameters for Treatment by Posttest Conditions associated with the saturated model were examined. The Lambda's and Tau's along with univariate significance are presented in Table 6.

Table 6
Log-Linear Parameters and Their Associated Tests of Significance

Posttest	Treatment: Experimental			Control		
	Lambda	Tau	$\frac{\lambda}{\sigma}$ - test	Lambda	Tau	$\frac{\lambda}{\sigma}$ - test
Equiprobable	0.109	1.115	0.53	-0.109	0.897	-0.53
Analytic	0.636	1.888	2.20	-0.636	0.530	-2.20
Evidential	-0.276	0.759	-1.29	0.276	1.318	1.29
Declarative	-0.568	0.626	-1.54	0.276	1.597	1.54

Examination of Table 6 reveals significance of simple main effects only for the analytic category where $\frac{\lambda}{\sigma} = 2.20$, $p \leq 0.014$, indicating a greater number of analytic statements by the Reflective Teaching groups on the posttest than the control groups. The same interpretation was found by examining the first-order model. The Treatment by Posttest marginals associated with the saturated model is presented in Table 7.

Table 7
Marginal Frequencies Associated with the Saturated Model for Teaching Stem Completion by Treatment and Posttest

Posttest	Treatment: Experimental	Control
Equiprobable	20	13
Analytic	17	2
Evidential	11	19
Declarative	7	12

Visual examination of this table supports the logit analysis.

Analysis of the data for Learning Stem Completion followed the same Log-Linear analysis procedure with the Posttest condition being the logit as was done for the Teaching Stem Completion data. Consequently, Tables 8, 9, and 10 are shown for examination of the observed frequencies, hierarchical analysis, and the logit analysis respectively.

Table 8
Observed Frequencies for Learning Stem Completion
by Treatment, Pretest and Posttest Conditions

Posttest (C)	Posttest (B)	Treatment (A) Experiment	Control
Equiprobable	Equiprobable	4	2
	Analytic	4	4
	Evidential	5	3
	Declarative	1	3
Analytic	Equiprobable	8	2
	Analytical	8	1
	Evidential	6	1
	Declarative	1	1
Evidential	Equiprobable	4	4
	Analytic	2	2
	Evidential	4	14
	Declarative	2	0
Declarative	Equiprobable	1	1
	Analytic	1	2
	Evidential	2	5
	Declarative	2	1

Table 9
Summary of Hierarchical Analysis for Learning Stem Completion by Treatment, Pretest and Posttest Conditions

model	Residual Chi-Square			Component Chi-Square		
	χ^2_{LR}	df	p	χ^2comp	df	p
(0)	53.76	30	0.005	68.65	1	0.000
(1)	39.48	28	0.074	44.35	1	0.026
(2)	48.62	28	0.009	55.43	1	0.002
(3)	29.31	21	0.107	28.68	1	0.122
(4)	20.51	21	0.489	20.65	1	0.480
(5)	22.05	15	0.107	20.77	1	0.145
(6)	8.09	9	0.525	8.16	1	0.518
(7)	0.0	0	1.000	0.0	1	1.000

Note: $\sum_{i=0}^{7} \chi^2$ comp = 246.69

Table 10
Logit Analysis of Learning Stem Completion by Treatment and Pretest Conditions

source	df	χ^2_{LR}	p
Total	21	29.31	
Due to Pretest	9	10.92	0.282
Due to Treat/Pretest	3	10.31	0.016
Due to Interaction	9	8.09	0.525

Examination of these tables reveal that the best fitting model was the full first-order interaction indicating conditional main effects, i.e., main effects due to treatment while partialling out the Pretest (χ^2_{LR} = 10.31, $p \leq 0.016$ with 3 degrees of freedom). The parameters for Treatment and Posttest Conditions associated with the full-first order interaction model were examined to follow up this main effect. Presented in Table 11 are the Lambda's and Tau's with the univariate significance.

Table 11
Log-Linear Parameters and Their Associated Tests of Significance

Posttest	Treatment: Experimental Lambda	Experimental Tau	Experimental χ - test	Control Lambda	Control Tau	Control χ - test
Equiprobable	-0.026	0.974	-0.15	0.026	1.026	0.15
Analytic	0.527	1.693	2.61	-0.527	0.590	-2.16
Evidential	-0.280	0.756	-1.33	0.280	1.323	1.33
Declarative	-0.221	0.802	-1.04	0.221	1.247	1.04

Similarly, as with the Teaching Stem Completion, Table 11 discloses significance of simple main effects only for the Analytic Category, $\chi = 2.61$, $p \leq 0.005$, thereby revealing that the Reflective Teaching groups had considerably more analytic statements on the posttest than did the participants in the control groups. Further for this logit analysis is given in Table 12, the Treatment by Posttest marginals associated with the saturated model.

Table 12
Marginal Frequencies Associated with the Saturated Model
For Learning Stem Completions by Treatment and Posttest

Posttest	Treatment: Experimental	Control
Equiprobable	14	12
Analytic	23	5
Evidential	12	20
Declarative	6	9

The log linear analysis supports the initial assertion that the Reflective Teaching treatment is associated with the generation of more analytic statements than was the control condition.

Discussion of Results

On the basis of both the log-linear analysis and the simple inspection of the reported results, there is support for the hypothesis which makes sense in light of the experiment. The analytic category asks for a concrete relation of one's consideration of teaching. Since each of the experimental subjects had 6 teaching experiences--either as a teacher or as a learner--and that each of these teaching

events was followed by 30 to 40 minutes in which all of the participants were asked to reflect on that experience by recalling its details and by speculating on the significance of those details, it makes sense to think that students in the experimental groups would have a richer set of experiences (richer in the sense of being concrete and specific) than those in the control sections on which to draw when asked what they think about teaching and learning in a context apart from RT.

In addition, both the log-linear analysis and the simple inspection of the Tables suggests support for the hypothesis in the learning statements as well. The experimental subjects show the greatest change in the Analytic category while the Control group shows a negative change (-6) in that category. The strong positive change in the Declarative category of the Control group may be attributable to the apparent hostility that showed up in the posttest completions of one Control Section. The students in this section expressed dissatisfaction with the way the regular instructor conducted the course. Students in this section may have expressed part of their disapproval by not working as hard as they might have to respond to the stem.

Still, it is apparent that students who had been exposed to the Reflective Teaching treatment increased the percentage of analytical statements in completing both the stems "When I think about teaching/learning..." The increase is greater than that of the control section (+13% to +1%) indicating positive support for the hypothesis.

These results suggest the following conclusion: that indeed Reflective Teaching influences the ability (or propensity) of students to think (as shown in their written statements) more critically--that is, in more complex grammatical and syntactical structures--about teaching and learning.

Supplementary support

A further corroboration of the experimental results, while impressionistic in nature, comes from the video tape record. During the initial analysis of the data, the video tape record was transcribed by two of the investigators. It was the impression of the investigators that the Reflective Teaching students were engaged actively with the treatment. This engagement appeared to entail the need to restructure assumptions about teaching based on new experience with teaching. For example, a designated teacher who had a small number of learners asserted during the large group discussion that there was no way that the material (The Magic Squares Task) could have been taught successfully. However, two other designated teachers teaching the same task had a high degree of success when measured as student achievement and satisfaction. It was apparent that the subsequent discussion, witnessed the first designated teacher attempting to readjust his intital hunch. Finally, he began to wonder what he could have done differently during the teaching. The fact of successful teaching in his class seemed to make the designated teacher reinterpret and direct his attention to his own teaching rather than to the materials or the program. Such an impression seems to lend support to the hypothesis--not only do the experimental results tend to bear it out, but the video tape record seems to show the "mechanism" by which students learn to think and talk critically.

The instrument consisted of a stem: "As a result of your 6 hours experience with Reflective Teaching to what extent do you believe..." that was followed by 35 statements which completed the stem. Each of these statements was based on the projected advantages of Reflective Teaching for preservice teachers. For example, one of the completions was "... to what extent do you believe you are better able to identify factors that affect teaching and learning?" The participants were asked to respond to each of these completions of the stem as to their relative belief or disbelief by marking a scale of 1 (strongly believe) to 6 (strongly disbelieve).

While such statements ask for an assertion of belief and do not provide evidence of the factuality of that belief on the part of the experimental students, the response to these statements should be interesting to the investigator as well as those interested in Reflective Teaching as an instructional alternative for education classes.

Specifically to the hypothesis, three statements of the set are relevant:

8) "...do you believe you could better project hypotheses about teaching and learning?"

9) "...do you believe that you feel more positively to reflecting on talking about teaching?"

15) "...do you believe you are able to think of a greater variety of ways to accomplish a learning objective?"

To each of these statements, the majority of participants in Reflective Teaching responded positively. 61.8% of the participants believed that they were better able to project hypotheses about teaching and learning. 74.5% of the participants reported feeling more positive toward reflecting on and talking about teaching. This result tends to confirm or support the data generated in the When I think about teaching learning statements. Finally, 80% of the participants responded that they believed they were now (as a result of the Reflective Teaching experience) better able to think of a variety of ways to accomplish a learning task. This last statement was placed with the hypothesis because it makes common sense to think that one who can more precisely analyze a teaching event, would be better able to think of a variety of ways to accomplish a specific teaching goal.

By self-report, the participants in the experimental sections of the field experiment also support the hypothesis.

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